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# Application of Fuzzy AHP in Selection of Accounting Elective Courses in Undergraduate and Graduate Level

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**Abstract**
Elective courses, provide students development in terms of interest and ability consist important part of education system and can be used as effective tool for making career plan. Additionally they play important role in curriculum and education quality development. In this study selection criteria of accounting elective courses in business undergraduate and accounting graduate education are determined from the viewpoint of students. For this purpose survey consisting of course selection main criteria and sub-criteria was designed and conducted with final year students in business administration undergraduate and accounting graduate level students via four different fuzzy ranking methods. Furthermore, result of this methods were compared too.

## 1. Introduction

Education system has an important role in countries development. Qualified and sophisticated personnel requirement is started to increase for especially developing countries in rapidly changing world. In addition to that government budget allocated for education system has increased gradually. Higher education programs especially in America and European countries are arranged and updated according to the changing conditions in order to train individuals having different specifications.

Undergraduate and graduate education programs are being tried to develop in Turkey according to the directions of Bologna process. Elective course ratio in undergraduate programs is arranged by Council of Higher Education in 2010 and considered as 25 percent with respect to Bologna process (Kaya & Üstün, 2013, p.16).

Elective courses, aim students development in terms of interest and ability, can be defined as course students can select from list according to their relevancy (Aybar et al., 2004, p.147). Students can be satisfied from their departments and academic achievements by means of elective courses. Because students can acquire knowledge toward area of interests and develop abilities in different fields via elective courses. Furthermore they can take lessons from different departments and classes in terms of career plans and share knowledge and experience each other.

Elective course application is one of the most effective tools that students use for knowledge and skill development in terms of career plans throughout education life. Making a career plan improving oneself within this framework have an importance for students in business administration department that leads employment opportunity in public and private sector. It is not possible to be a specialized person after having undergraduate level education in business administration department that train students for different working areas such as accounting, marketing, finance, production management and organization. For that reason more elective courses aim to direct student careers with respect to interest and abilities should take part in curriculum.

Presenting accounting lesson in curriculum preparation process within the framework of provided job sufficiency has gain importance for accounting education. International Federation of Accountants (IFAC) which is Professional organization for accounting job in the global scale, arrange principles, standarts and instructions to gain better performance (https://www.ifac.org/). IFAC regulates international education standards with regard to

accounting education. Education standards consist of conditions provide acceptance of member of a profession to organizations which are a member of IFAC. Preparation of academic programs by considering minimum education conditions mentioned in the standards cause improving education quality.

Accounting education should be composed of issues related to accounting, finance, organization, business and information Technologies according to the IFAC international education standards. In this context sufficiently accounting based elective courses besides compulsory accounting and business administration ones should take place in the curriculum for students having accounting career plan.

Another international organization determining standards related to business and accounting curriculum is named as Association to Advance Collegiate Schools of Business (AASCB) International. Mission of this non-profit making organization is to improve business education by providing accreditation and value added services (http://www.aacsb.edu/). According to the AACSB International students in business administration department should select half of courses from out of business program (AACSB, 2013). For that reason curriculum of business administration nedds to be enriched by elective and compulsory non-department courses.

## 2.Literature Review

There are a lot of studies that aim to make a proposal toward arranging a better business department curriculum; examine the effect of Bologna process on business-accounting education in the context of department curriculum and consider elective courses based on business-accounting education. Apart from that there are no studies investigating the accounting based elective courses specifically.

Zaif and Ayanoğlu (2007) analyzed the curriculums of business departments in Turkey to evaluate the accounting education quality. Within this context 59 syllabus are considered. According to the evaluations programs consist of 150 credits on average, 137 of them (%91) are compulsory and 23 of them (%9) are elective courses. Furthermore 14 percent of compulsory courses and 13 percent of elective ones are accounting based. According to the analysis results number of elective courses, their credit sufficiency and the ratio of accounting courses in total are found as low.

McCuudy, Pınar and Gingerich (2008) aim to make proposals for overcoming problems encountered in designing student based curriculum by considering their opinions. According to the research outcomes the most important director in the curriculum development process are found as organization survival and employer claims that modelled with changing marketing requirements and need qualified work-force. Within this context student requests related to curriculum are formed by changing economic environment. Number of students want to be specialized in the accounting field arose with salary increase and new job opportunities after application of new accounting controls and supervisory requirements within the framework of Sarbanes-Oxley Act. In addition to this more compulsory and elective accounting based courses should take place in student based prepared curriculums.

Subaşı and Demir (2009) identified 7 accounting compulsory courses for public universities and 3 for private ones on average by examining curriculums of business administration programs in 74 universities in Turkey. According to the analysis results while accounting courses are included in curriculums for public universities, it is not possible for private ones. Furthermore elective accounting courses are taught predominantly in third and fourth academic years.

Lyons (2012) designed graduate curriculum aims to reflect needed knowledge for achievement and leadership development via study proposed to define details of curriculum change and summarize application process for graduate programs in Faculty of Business in Berkeley. Compulsory courses of designed program curriculum constitute 40 percent of total and aim to develop student abilities in some areas such as finance, marketing and accounting. Elective courses, form 60 percent of curriculum and recommend for sophomore, can be selected with purpose of extensively study. While students learn core skills from compulsory courses they can select elective ones in terms of interest areas.

Terzi, Şen and Solak (2013) examined and reviewed the academic programs of business administration departments for both public and private universities in Turkey with respect to national credit and European Credit Transfer System (ECTS). According to the research gainings although the number of elective courses in business administration departments is not able to achieve the 25percent of total credit as demanded level for Bologna process yet, it has been increasing. Furthermore it is defined that while academic program of public universities consist of 194 credit compulsory and 135 credit elective courses; 180 credit compulsory and 126 credit elective courses comprised academic program of private ones in terms of ECTS evaluation process. Among these courses while curriculum of public

universities consist of 30 credit compulsory and 19 credit elective accounting courses, academic program of private ones comprised of 20 credit compulsory and 14 credit elective accounting courses.

Marşap, Elitaş and İşgüven (2015) investigated the academic program of 13 universities in Turkey for reducing the number of compulsory courses, increasing elective ones and detecting the effect on accounting with Bologna process adaptation. As a result of reviewing process it is defined the inadequacy of compulsory and elective accounting courses in some departments. Due to Bologna process number of compulsory courses has decreased and there is not enough accounting based elective courses for many departments.

Elective course selection is a decision making process and many of factors affecting this process are subjectively oriented. Importance level of determined criteria over anothers differentiate according to each student. Elective course application is structured considering factors affecting students' decision making process via determining the selection criteria of elective courses.

Purpose of this study is to determine the selection criteria of accounting elective courses in business ungraduate and accounting graduate education from the viewpoint of students and ensure appropriately usage of elective courses in design of decision problem with regard to accounting undergraduate and graduate education. Thus elective courses in undergraduate and graduate levels can be reconsidered by dealing the needs of accounting education and job. In this study importance levels of selection criteria of elective courses are obtained and compared via usage of four different fuzzy ranking methods. Data for this study are acquired from the final year students in business administration undergraduate and accounting graduate education.

## 3.Methodology

### 3.1.Fuzzy Sets Theory and Fuzzy Numbers

Zadeh (1965) firstly proposed a mathematical theory namely fuzzy set in order to overcome vaguness and imprecise condition of human cognitive processes (Jie, Meng and Cheong, 2006, p.1). Fuzzy term refers to ambiguity and vagueness situation (Bellman & Zadeh, 1970; Zebda, 1989). Apart from classical set theory based on binary logic fuzzy set describe actual objects similar to human language (Huang & Ho, 2013, p. 983). A fuzzy set which is extension of crisp one allow partial belonging of element by membership function. Membership values

of objects in a fuzzy set range from 0 (nonmemberhip) to 1 (complete membership). Values between these boundaries are called intermediate membership degrees and show degree to which an element belongs to a set (Ertuğrul & Karakaşoğlu, 2009, p.704). According to Huang and Ho (2013) a fuzzy set ( $\tilde{A}$ ) can be defined as follows:

$$\tilde{A} = \left\{ (x, \mu_{\tilde{A}}(x)) \middle| x \in U \right\} \quad (1)$$

According to equation (1) $\mu_{\tilde{A}}(x)$ is membership function and ranges between 0 and 1, U is called the universe of discourse. A fuzzy number such as $\tilde{\mathrm{A}}$ has following chracteristics:

1- $\mu_{\tilde{A}}(x)$ is a continuous mapping from R to closed interval $[0,1]$. 2- $\mu_{\tilde{A}}(x)$ is a convex fuzzy subset. 3- $\mu_{\tilde{A}}(x)$ is the normality of a fuzzy subset which means that there exists a number $\mathrm{x}_0$ that makes $\mu_{\tilde{\mathrm{A}}}(\mathrm{x}_0) = 1$ (Dubois & Prade, 1978, p.613-614).

Fuzzy logic provide more widely frame than classical set and handle real world applications efficiently compared traditional mathematical tools (Ertuğrul & Tuş, 2007). It models uncertain, complex situations in case of imprecise and incomplete information. Fuzzy logic takes into human subjectivity and imprecision of human behavior the account, and try to find good approximate solution (Bojadziev & Bojadziev, 1998). Main advantage of fuzzy set theory is capability of representing ambiguous data and allowing mathematical operators to apply in fuzzy domain (Mahmoodzadeh, Shahrabi, Priazar & Zaeri, 2007, p.272).

Triangular and trapezoidal fuzzy numbers are one of the mostly used in practice (Baykal & Beyan, 2004). Triangular fuzzy numbers are used in this study due to computational easiness and representation usefulness. Membership of triangular fuzzy number is defined by three real numbers expressed as (l,m,u) indicating smallest possible value, the most promising value and the largest possible value respectively (Deng, 1999, p.217). Representation of triangular fuzzy numbers is showed in following equation (Jie, Meng & Cheong, 2006, p.3):

$$\mu_{\tilde{A}}(x) = \begin{cases} (x-l)/(m-l), l \le x \le m, \\ (u-x)/(u-m), m \le x \le u, \\ 0, otherwise \end{cases} \quad (2)$$

Three important operational laws (addition, multiplication and reciprocal) for two fuzzy numbers defined by $\tilde{\mathrm{A}}_1 = (l_1, m_1, u_1)$ and $\tilde{\mathrm{A}}_2 = (l_2, m_2, u_2)$ respectively are illustrated as follows (Deng, 1999, p.217-218):

$$\tilde{A}_1 \oplus \tilde{A}_2 = (l_1, m_1, u_1) \oplus (l_2, m_2, u_2) = (l_1 + l_2, m_1 + m_2, u_1 + u_2)$$
$$\tilde{A}_1 \otimes \tilde{A}_2 = (l_1, m_1, u_1) \otimes (l_2, m_2, u_2) \approx (l_1.l_2, m_1.m_2, u_1.u_2) \quad (3)$$
$$\tilde{A}_1^{-1} = (l_1, m_1, u_1)^{-1} \approx \left(\frac{1}{u_1}, \frac{1}{m_1}, \frac{1}{l_1}\right)$$

A triangular fuzzy number ( $\tilde{M}$ ) is shown in Figure 1 (Jie, Meng & Cheong, 2006, p.3).

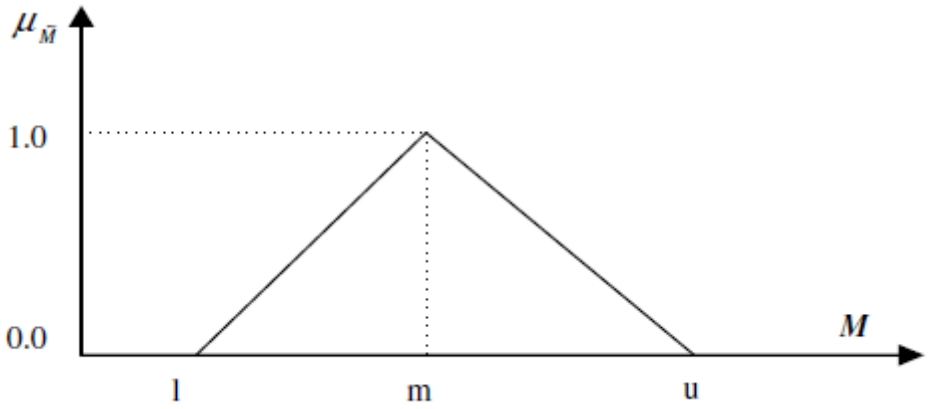


**Figure 1.** Triangular fuzzy number ( $\tilde{M}$ )

Ranking fuzzy numbers in imprecise and vagueness environment is one of the essential problems in fuzzy optimization and fuzzy decision making. Fuzzy values are ranked according to different specifications of fuzzy sets namely centre of attraction, area under the membership degree function and some intersection points. There are different fuzzy ranking methods in the literature and present various results for same data. Each method has specific pros and cons so it is difficult to make decision about which method is the best one (Chen, Hwang and Hwang, 1992). Various fuzzy ranking methods can be used according to the complexity, sensitivity, easily interpretability of existing problem and type of fuzzy numbers (Kaptanoğlu & Özok, 2006,198). Fuzzy ranking methods took place in literature can be summarized as Yager (1981), Dubois and Prade (1983), Buckley (1985), Chen (1985), Kim and Park (1990), Liou and Wang (1992), Choobineh and Li (1993), Chang (1996), Cheng (1998), Raj and Kumar (1999), Yao and Wu (2000), Abdel-Kader and Dugdale (2001), Matarazzo and Munda (2001), Ezzati, Allahviranloo, Khezerloo and Khezerloo (2012).

### 3.2.Fuzzy Analytic Hierarchy Process (FAHP)

Analytic Hierarchy Process (AHP), one of the most widely used multi criteria decision making (MCDM) methods proposed by Saaty (1980) use exact values to express decision maker's opinion in pairwise comparison process by handling both qualitative and

quantitative data (Ertuğrul & Karakaşoğlu, 2009, p.705). This method decomposes complicated problems from higher hierarchies to lower one and employ the sub-system perspective endowed in system (Tsaur, Tzeng & Wang, 1997, p.800). Despite these specifications, AHP can not reflect human thinking style in inaccurate and subjective environment due to unbalanced scale of judgments, inability to adequately handle inherent uncertainty and imprecise pair-wise comparisons (Deng, 1999; Kahraman, Cebeci & Ulukan, 2003). For that reason fuzzy analytic hierarchy process (FAHP) extension of traditional AHP was developed to solve hierarchical fuzzy problems in interval judgment matrix (Kahraman et al., 2003, p.386-387). FAHP integrate traditional AHP and fuzzy set theory (Wang, Fan & Wang, 2010, p.8518). FAHP reflect clarity, vagueness and blur of human thinking style compared to traditional AHP (Huang & Ho, 2013, p.985). Pair-wise matrices consisted of triangular fuzzy numbers are given as below (Wang, Luo & Hua, 2008, p.736).

$$\tilde{A} = (\tilde{a}_{ij})_{nxn} = \begin{bmatrix} (1,1,1) & (l_{12}, m_{12}, u_{12}) & \dots & (l_{1n}, m_{1n}, u_{1n} \\ (l_{21}, m_{21}, u_{21}) & (1,1,1) & \dots & (l_{2n}, m_{2n}, u_{2n}) \\ \vdots & \vdots & \vdots & \vdots \\ (l_{n1}, m_{n1}, u_{n1}) & (l_{n2}, m_{n2}, u_{n2}) & \dots & (1,1,1) \end{bmatrix} \quad (4)$$

Fuzzy set theory allow respondents to explain semantic judgments subjectively (Huang and Ho, 2013, p.985). For this reason Saaty's 9 point scale is transformed into the fuzzy ratio scale in terms of triangular fuzzy numbers and shown in Table 1.

**Table 1.** Fuzzy evaluation scores used for the weights

| **Saaty's relative importance** | **Linguistic terms** | **Fuzzy score** |
|---|---|---|
| $C_{ij} = 1$ | Equally important | (1,1,1) |
| $C_{ij} = 2$ | Intermittent value between two adjacent scale | (1,2,3) |
| $C_{ij} = 3$ | Weekly important | (2,3,4) |
| $C_{ij} = 4$ | Intermittent value between two adjacent scale | (3,4,5) |
| $C_{ij} = 5$ | Fairly important | (4,5,6) |
| $C_{ij} = 6$ | Intermittent value between two adjacent scale | (5,6,7) |
| $C_{ij} = 7$ | Strongly important | (6,7,8) |
| $C_{ij} = 8$ | Intermittent value between two adjacent scale | (7,8,9) |
| $C_{ij} = 9$ | Absolutely important | (8,9,9) |

FAHP present better results than traditional AHP in which basis of priorities are comprised of decision makers' perception based judgments and thereby many researchers are interested in FAHP rather than traditional one. First study related to FAHP is made by Van Laarhoven and Pedrytcz (1983) and they proposed a model using triangular fuzzy numbers. Buckley (1985) developed a model to state decision maker's evaluation on alternatives with respect to each criterion by using trapezoidal fuzzy numbers. Chang (1996) introduced a new model for dealing FAHP by using triangular fuzzy numbers for pair-wise comparison scale and extent analysis for synthetic extent values of pair-wise comarisons. Deng (1999) proposed a fuzzy approach for treating qualitative multi-criteria analysis problems. Chou and Liang (2001) developed a fuzzy MCDM model integrating fuzzy set theory, entropy and AHP for shipping company performance evaluation. Tüysüz and Kahraman (2006) proposed an analytic tool with the help of FAHP for evaluating the riskiness of project under imprecise and incomplete environment. Chan and Kumar (2007) presented fuzzy extend AHP framework to select the global supplier. Lee, Chen and Chang (2008) proposed an integrated approach comprising FAHP and balanced scorecard to evaluate the performance of IT department in manufacturing industry in Taiwan.

### 3.2.1. Chang's Extent Analysis Method on FAHP (1996)

Chang (1996) proposed an approach for dealing FAHP by using triangular fuzzy numbers for pairwise comparison and considering extent analysis for synthetic extent values of comparisons. Let $X = \{x_1, x_2, \ldots, x_n\}$ be an object set and $U = \{u_1, u_2, \ldots, u_n\}$ be a goal set. According to Chang's (1996) extent analysis each objective is taken and extent analysis for each goal is performed respectively. So m extent analysis values for each object can be obtained with the following signs:

$$M_{g_i}^1, M_{g_i}^2, \ldots, M_{g_i}^m, \qquad i = 1,2,\ldots,n \tag{5}$$

Where all the $M_{g_i}^j \ (j = 1,2,\ldots,m)$ are triangular fuzzy numbers. Steps of Chang's extent analysis can be given as follows:

1-The value of fuzzy synthetic extent with respect to the ith object is defined as:

$$S_i = \sum_{j=1}^{m} M_{g_i}^j \otimes \left[ \sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^j \right]^{-1} \tag{6}$$

To obtain $\sum_{j=1}^{m} M_{g_i}^{j}$ the fuzzy addition operation of m extent analysis values for a particular matrix is performed such as

$$\sum_{j=1}^{m} M_{g_i}^{j} = (\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j) \quad (7)$$

and to obtain $\left[\sum_{j=1}^{n}\sum_{j=1}^{m} M_{g_i}^{j}\right]^{-1}$ the fuzzy addition operation of $M_{g_i}^{j}(j = 1,2,\ldots,m)$ values is performed such as

$$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{g_i}^{j} = (\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i) \quad (8)$$

and then the inverse of the vector above is computed such as

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{g_i}^{j}\right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i}\right) \quad (9)$$

2-The degree of possibility of $M_2 = (l_2, m_2, u_2); M_1 = (l_1, m_1, u_1)$ is defined as:

$$V(M_2 \geq M_1) = \sup_{y \geq x}\left[\min(\mu_{M_1}(x), \mu_{M_2}(y))\right] \quad (10)$$

and can be expressed as follows:

$$V(M_2 \geq M_1) = hgt(M_1 \cap M_2) = \mu_{M_2}(d) \quad (11)$$

$$= \begin{cases} 1, & if\ m_2 \geq m_1 \\ 0, & if\ l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & otherwise \end{cases} \quad (12)$$

Eq. (10) where d is the ordinate of the highest intersection point D between $\mu_{M_1}$ and $\mu_{M_2}$ is illustrated in Figure 2 (Chang, 1996). To compare $M_1$ and $M_2$, we need both the values of $V(M_1 \geq M_2)$ and $V(M_2 \geq M_1)$.

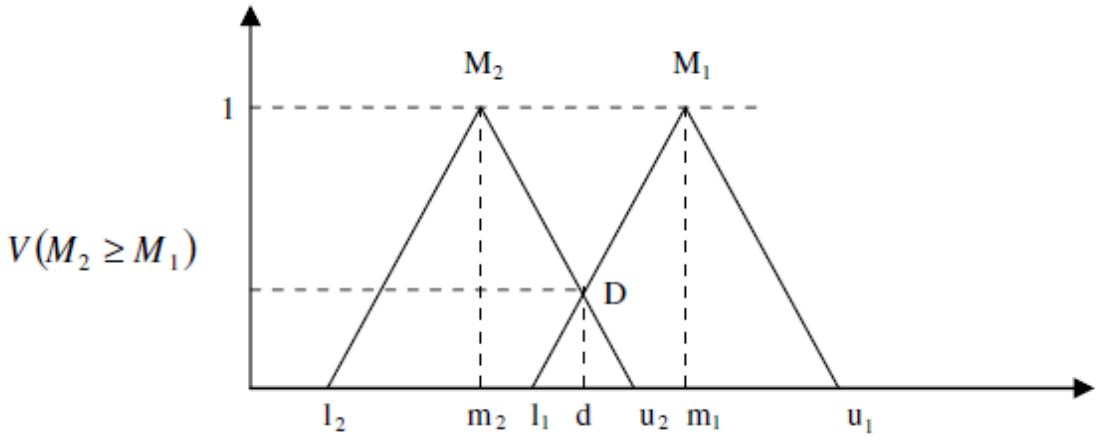


**Figure 2.** The definition of the degree of possibility of $V(M_2 \geq M_1)$

3-The degree possibility for a convex fuzzy number to be greater than k convex fuzzy $M_i (i = 1,2,\ldots,k)$ numbers can be defined by

$$V(M \geq M_1, M_2, \ldots, M_k) = V\left[(M \geq M_1) \text{ and } (M \geq M_2) \text{ and } \ldots \text{and } (M \geq M_k)\right] = \min V(M \geq M_i), i = 1,2,\ldots,k \quad (13)$$

Assume that $d(A_i) = \min V(S_i \geq S_k)$ for k=1,2,...,n; $k \neq i$.Then the weight vector is given by

$$W' = (d'(A_1), d'(A_2), \ldots, d'(A_n))^T \quad (14)$$

where $A_i (i = 1,2,\ldots,n)$ are n elements.

4-Via normalization, the normalized weight vectors are

$$W = (d(A_1), d(A_2), \ldots, d(A_n))^T \quad (15)$$

where W is a non-fuzzy number.

While computational easiness and compliance with stages of traditional AHP (additional process are not required) can be considered as advantages of this method, allowing only triangular fuzzy numbers, assigning zero weights to some relative importance values and neglecting important information, causing faulty decisions comprise disadvantage side (Wang, Luo & Hua, 2008, p.745).

### 3.2.2. Buckley's Column Geometric Mean Method (1985)

Steps of Buckley's (1985) method are given as follows:

1- Establishing hierarchical structure and comparing criteria or alternatives via fuzzy scale for constructing pair-wise comparison matrix shown as below:

$$\tilde{A}^k = \begin{bmatrix} \tilde{a}_{11}^k & \tilde{a}_{12}^k & \dots & \tilde{a}_{1n}^k \\ \tilde{a}_{21}^k & \tilde{a}_{22}^k & \dots & \tilde{a}_{2n}^k \\ \dots & \dots & \dots & \dots \\ \tilde{a}_{m1}^k & \tilde{a}_{m2}^k & \dots & \tilde{a}_{mn}^k \end{bmatrix} \quad (16)$$

2-Preferences of all decision makers are averaged according to Eq. (17) and new pairwise comparison matrix is obtained as Eq. (18):

$$\tilde{a}_{ij} = \frac{\sum_{k=1}^{K} a_{ij}^k}{K} \quad (17)$$

$$\tilde{A} = \begin{bmatrix} \tilde{a}_{11} & \tilde{a}_{12} & \dots & \tilde{a}_{1n} \\ \tilde{a}_{21} & \tilde{a}_{22} & \dots & \tilde{a}_{2n} \\ \dots & \dots & \dots & \dots \\ \tilde{a}_{m1} & \tilde{a}_{m2} & \dots & \tilde{a}_{mn} \end{bmatrix} \quad (18)$$

3-Geometric mean of each criterion is calculated according to Eq. (19):

$$\tilde{z}_i = \left[ \prod_{j=1}^{n} \tilde{a}_{ij} \right]^{1/n}, \ i=1,2,...,m \quad (19)$$

4-The fuzzy weights $(\tilde{w}_i)$ of each criterion are obtained by finding vector summation of each $\tilde{z}_i$, acquiring (-1) power of summation vector and replacing in an increasing order, and finally multiplying $\tilde{z}_i$ with reverse vector according to Eq. (20):

$$\tilde{w}_i = \tilde{z}_i \otimes (\tilde{z}_1 \oplus \tilde{z}_2 \oplus \dots \oplus \tilde{z}_n)^{-1} = (l_i, m_i, u_i) \quad (20)$$

5-Fuzzy weights composed of fuzzy triangular numbers are transformed into crisp one by using Center of Area defuzzification techniques shown in Eq. (21):

$$S_i = \frac{l_i + m_i + u_i}{3} \quad (21)$$

6-After obtaining crisp weights normalization process is implemented such as Eq. (22):

$$T_i = \frac{S_i}{\sum_{i=1}^{m} S_i} \quad (22)$$

### 3.2.3. Liou and Wang Method (1992)

Liou and Wang (1992) proposed an approach for ranking fuzzy numbers simultaneously by using total integral value apart from the type and normality of membership function. Total integral value for a triangular fuzzy number such as $\tilde{A} = (l, m, u)$ is calculated as Eq. (23):

$$I_T^{\alpha}(A) = \frac{1}{2}\alpha(m+u) + \frac{1}{2}(1-\alpha)(l+m) = \frac{1}{2}[\alpha.u + m + (1-\alpha).l] \quad (23)$$

According to the index of optimism defined as $\alpha \in [0,1]$ decision maker has an optimistic $(\alpha = 1)$, consensus $(\alpha = 0.5)$ or pessimistic $(\alpha = 0)$ viewpoint. Any two triangular fuzzy numbers such as $\tilde{D}_i$ and $\tilde{D}_j$ can be compared as Eq. (24):

$$\begin{aligned} &I_T^{\alpha}(\tilde{D}_i) < I_T^{\alpha}(\tilde{D}_j) \Rightarrow \tilde{D}_i < \tilde{D}_j \\ &I_T^{\alpha}(\tilde{D}_i) = I_T^{\alpha}(\tilde{D}_j) \Rightarrow \tilde{D}_i = \tilde{D}_j \\ &I_T^{\alpha}(\tilde{D}_i) > I_T^{\alpha}(\tilde{D}_j) \Rightarrow \tilde{D}_i > \tilde{D}_j \end{aligned} \quad (24)$$

### 3.2.4. Abdel- Kader and Dugdale Method (2001)

According to Abdel- Kader and Dugdale (2001) a fuzzy triangular is divided into three parts namely full memberships, partial memberships located in left-hand side and partial memberships located in right-hand side. Existing fuzzy ranking methods either reflect membership functions of the left-hand side or both sides. Therefore Abdel-Kader and Dugdale (2001) proposed a new approach reflecting all three parts of fuzzy number in the ranking process by using an index of optimism $(\alpha)$ in the closed interval $[0,1]$.

For fuzzy numbers $\tilde{A}_1 = (l_1, m_1, u_1)$, $\tilde{A}_2 = (l_2, m_2, u_2)$, ..., $\tilde{A}_k = (l_k, m_k, u_k)$ k=1,2,...,N

$S = (l_1, m_1, u_1, l_2, m_2, u_2, \ldots, l_k, m_k, u_k)$ and $V(\tilde{A}_k)$ which is the value of $\tilde{A}_k$ can be computed as :

$$V(\tilde{A}_k) = m_k \left\{ (\alpha)\left[ \frac{u_k - x_{min}}{x_{max} - x_{min} + u_k - m_k} \right] + (1-\alpha)\left[ 1 - \frac{x_{max} - l_k}{x_{max} - x_{min} + m_k - l_k} \right] \right\} \quad (25)$$

$$x_{min} = \inf S \quad (26)$$

$$x_{max} = \sup S \quad (27)$$

## 4.Analysis

In application process a survey determining the selection criteria of accounting elective courses in business undergraduate and accounting graduate level students was designed and conducted. Survey was applied between the dates 24 April 2016 and 10 May 2016 in order to determine weights of selection criteria. As a result 61 complete survey for undergraduate level 11 for graduate level were collected and analyzed. While defining the criteria and sub criteria, first of all, researchers made a depth literature review in order to develop the draft of the scale. In order to calculate weights of criteria and sub-criteria Buckley's (1985) column geometric mean method, Chang's (1996) extent analysis method, Liou and Wang method and Abdel-Kader and Dugdale method is adopted. . Four fuzzy ranking models are considered due to easily interpretability of available problem namely accounting course selection, models' compliance to problem and computational easiness in terms of triangular fuzzy numbers against other models. Weights acquired from these methods are compared.

Firstly transformed fuzzy ratio scale is used for constructing pair-wise comparison matrix by decision makers. According to Chang's extension method weights of main criteria being zero so to overcome this disadvantage firstly Saaty's 9 point scale is carried out by decision makers to construct pair-wise comparison matrix. Then adopting Eq. (28) proposed by Chen, Lin and Huang (2006) decision makers' pairwise comparison values are transformed into triangular fuzzy numbers and comprehensive pairwise comparison matrix is acquired. Let the fuzzy rating and importance weight of the *k*th decision maker be $\tilde{x}_{ijk} = (a_{ijk}, b_{ijk}, c_{ijk})$; i=1,2,...,m and j=1,2,...,n respectively. So the aggregated fuzzy ratings $(\tilde{x}_{ij})$ of alternatives with respect to each criterion can be calculated as below:

$(\tilde{x}_{ij}) = (a_{ij}, b_{ij}, c_{ij})$ where

$$l_{ij} = \min_k \{a_{ijk}\}, \qquad m_{ij} = \frac{1}{K}\sum_{k=1}^{K} b_{ijk}, \qquad u_{ij} = \max_k \{d_{ijk}\} \quad (28)$$

After applying four fuzzy ranking method weights and ranks (given in paranthesis) of main criteria for undergraduate students are acquired as Table 2:

**Table 2.** Weights and ranks of main criteria for undergraduate students according to different fuzzy ranking methods

| Criteria | Chang's method | Buckley's method | Liou and Wang method (α=0,5) | Abdel-Kader and Dugdale method (α=0,5) |
|---|---|---|---|---|
| University related | .335862 (2) | .411791 (1) | .376094 (2) | .413559 (2) |
| Course related | .338584 (1) | .370711 (2) | .414078 (1) | .530340 (1) |
| Lecturer related | .325554 (3) | .217497 (3) | .209828 (3) | .056101 (3) |

As it can be seen from Table 2 course related main criteria was found as the most important one according to three fuzzy ranking methods apart from Buckley's method which reveal the most important main criteria as university related one. On the other hand, lecturer related main criteria was found as the least important one for all fuzzy ranking methods.

Accordingly, global weights and ranks of sub-criteria for undergraduate students are obtained and given in Table 3:

**Table 3.** Global weights and ranks of sub-criteria for undergraduate students according to different fuzzy ranking methods

| Sub-criteria | Chang's method | Buckley's method | Liou and Wang method (α=0,5) | Abdel-Kader and Dugdale method (α=0,5) |
|---|---|---|---|---|
| Compliance of elective courses | .086871 (1) | .199035 (1) | .163228 (1) | .267758 (2) |
| Physical specifications of classes | .083673 (3) | .090002 (3) | .088303 (5) | .070228 (5) |
| Overlapping courses | .083729 (2) | .078852 (5) | .089198 (4) | .071837 (4) |
| Quota problem | .081587 (4) | .043900 (11) | .035362 (13) | .003734 (13) |
| Course difficulty level | .069292 (5) | .112483 (2) | .129313 (2) | .276958 (1) |
| Selection by entourage | .066651 (9) | .048297 (10) | .054370 (9) | .022241 (8) |
| Necessity of course | .068036 (6) | .081452 (4) | .091883 (3) | .122043 (3) |

| Sub-criteria | Chang's method | Buckley's method | Liou and Wang method (α=0,5) | Abdel-Kader and Dugdale method (α=0,5) |
|---|---|---|---|---|
| Continuation of course | .067475 (7) | .065542 (7) | .074267 (6) | .067491 (6) |
| Useful for working environment | .067159 (8) | .062934 (8) | .064242 (7) | .041604 (7) |
| Mood of lecturer | .066145 (10) | .074065 (6) | .059171 (8) | .019744 (9) |
| Teaching style | .065702 (11) | .052173 (9) | .052228 (10) | .015168 (10) |
| Objective grading behaviour | .065121 (13) | .038782 (13) | .042476 (12) | .009876 (12) |
| Knowledge and experience | .065270 (12) | .039664 (12) | .044866 (11) | .011125 (11) |
| Title of lecturer | .063314 (14) | .012810 (14) | .011083 (14) | .000185 (14) |

According to the global weights of sub-criteria title of lecturer was found as the lowest ranked sub-criteria based on fuzzy ranking methods. On the other hand compliance of elective courses was found as the most important one for three fuzzy ranking methods out of Abdel-Kader and Dugdale method. Rankings of other sub-crtiteria differentiate for used fuzzy ranking methods. For instance while physical specifications of classes was found as the third ranking for Chang's and Buckley's method , it was found as the fifth ranking for Liou and Wang and Abdel-Kader and Dugdale method. According to the outputs of fuzzy ranking methods in terms of sub-criteria similar rankings are obtained out of quota problem. In other words while sub-criteria namely quota problem was ranked as the fourth most important one for Chang's method, it placed last positions for other ranking methods.

Similarly, weights and ranks of main criteria for graduate students are acquired as Table 4:

**Table 4.** Weights and ranks of main criteria for graduate students according to different fuzzy ranking methods

| Criteria | Chang's method | Buckley's method | Liou and Wang method (α=0,5) | Abdel-Kader and Dugdale method (α=0,5) |
|---|---|---|---|---|
| University related | .295225 (3) | .192977 (3) | .184025 (3) | .042254 (3) |
| Course related | .354481 (1) | .467462 (1) | .433735 (1) | .544428 (1) |
| Lecturer related | .350293 (2) | .339561 (2) | .38224 (2) | .413318 (2) |

According to the ranking outputs gained in terms of graduate students course related main criteria was found as the most important for all fuzzy ranking methods. Conversely, university related main criteria was obtained as the least important one.

Global weights and ranks of sub-criteria for graduate students are obtained and given in Table 5:

**Table 5.** Global weights and ranks of sub-criteria for graduate students according to different fuzzy ranking methods

| **Sub-criteria** | **Chang's method** | **Buckley's method** | **Liou and Wang method (α=0,5)** | **Abdel-Kader and Dugdale method (α=0,5)** |
|---|---|---|---|---|
| Compliance of elective courses | .077766 (2) | .103090 (4) | .096554 (5) | .035194 (7) |
| Physical specifications of classes | .073196 (8) | .034599 (10) | .036948 (10) | .004041 (10) |
| Overlapping courses | .072822 (9) | .034458 (11) | .032088 (11) | .002708 (11) |
| Quota problem | .071439 (11) | .020828 (13) | .018432 (13) | .000309 (14) |
| Course difficulty level | .080512 (1) | .228206 (1) | .198314 (1) | .383306 (1) |
| Selection by entourage | .055750 (13) | .027503 (12) | .024257 (12) | .001695 (12) |
| Necessity of course | .073271 (6) | .065323 (6) | .060319 (8) | .029461 (8) |
| Continuation of course | .069099 (12) | .036657 (9) | .037187 (9) | .008257 (9) |
| Useful for working environment | .075846 (4) | .109770 (3) | .113655 (3) | .121706 (3) |
| Mood of lecturer | .076357 (3) | .140867 (2) | .125832 (2) | .180297 (2) |
| Teaching style | .074411 (5) | .075002 (5) | .098104 (4) | .110865 (4) |
| Objective grading behaviour | .072098 (10) | .047804 (8) | .068959 (7) | .054046 (6) |
| Knowledge and experience | .073234 (7) | .064291 (7) | .076993 (6) | .067722 (5) |
| Title of lecturer | .054191 (14) | .011594 (14) | .012350 (14) | .000386 (13) |

As it can be seen from Table 5 sub-criteria namely title of lecturer placed last positions in analogy to fuzzy ranking outputs for undergraduate students. But as different from ranking results in terms of undergraduate students course difficulty level was ranked as the most important one. According to the outputs of fuzzy ranking methods in terms of sub-criteria similar rankings are obtained out of compliance of elective courses. In other words while sub-criteria namely compliance of elective courses placed first positions for Chang and Buckley's methods, it placed middle positions for other ranking methods.

## 5.Conclusion and Future Recommendations

Undergraduate and graduate education level is being tried to develop by means of Turkey's participation into Bologna Process since 2001. According to this process elective course ratio in undergraduate curriculum should be arranged as 25 percent. That increased the importance level of elective courses in curriculum preparation process. Thus students can take courses according to their interests and requirements and education quality has been increased. Elective courses scheduling in education programs should be made by taking students' needs and abilities into the account and that leads curriculums' quality development. In this study elective courses selection criteria in terms of undergraduate and graduate level are determined. More quality academic curriculums meeting students' expectations can be developed by means of using outputs of study.

According to the sub-criteria ranking results of four FAHP approaches in terms of undergraduate and graduate level students only title of lecturer was found as the least important one. Other sub-criteria ranking differentiate within different approaches. For example, while compliance of elective courses, course difficulty level, physical specifications of classes, necessity of course and overlapping courses were determined as the five most important sub-criteria for undergraduate students; course difficulty level, mood of lecturer, useful for working environment, teaching style and compliance of elective courses were considered as the important ones for graduate students. In addition to that title of lecturer, teaching style, knowledge and experience of lecturer, objective grading behavior and quota problem were found as the five least important sub-criteria for undergraduate students; physical specifications of classes, title of lecturer, quota problem, selection by entourage and overlapping courses were determined as the unimportant ones for graduate students. Sub-criteria have different weights in each approaches and this can be seen from table 3 and 5.

Four different FAHP approaches reveal the same results in terms of ranking course related main criteria as the most important one for undergraduate and graduate level students.

Apart from that ranking of other two main criteria differentiate in terms of four different FAHP approaches. Main criteria have different weights in each approaches and this can be seen from table 2 and 4.

These findings can be tested for its validaty in further researches. The researches may be designed as taking into consideration of different selection main criteria and sub-criteria. In addition to this, different weighting and ranking methods can be integrated with together and applied. Lastly, sample size can be increased in order to reach more reliable and valid results.

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